



## **INDEPENDENT INVESTIGATION INTO THE DARWIN-KATHERINE SYSTEM BLACK INCIDENT 12 MARCH 2014**

**A report to the Minister in accordance section 6(1)(g) of  
the *Utilities Commission Act***

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2 April 2014

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## **Purpose of this Report**

On 12 March 2014, the Treasurer (Regulatory Minister) asked the Utilities Commission (the Commission) to conduct an independent investigation into the System Black incident that occurred on that same day in relation to the Darwin-Katherine power system (System Black incident) and report the findings and advice of the Commission to the Minister.

This report sets out the initial findings and the advice of the Commission in relation to the matters referred to the Commission by the Minister on 14 March 2014 and is provided in accordance with section 6(1)(g) of the *Utilities Commission Act* (the Act).

In conducting the investigation and preparing this report, the Commission has had regard to the legislative objectives listed in section 6(2) of the Act. In particular, in performing this function the Commission has had regard to the need to protect the interests of consumers with respect to reliability and quality of services and supply in regulated industries.<sup>1</sup>

## **Confidential Information**

This report has been prepared using information provided by Power and Water Corporation (PWC). Some of this information may be considered to be commercially sensitive by PWC.

At this stage, PWC has not specifically claimed that any of the information it provided to the Commission, except its own investigation reports, is confidential information. However, if it is subsequently determined that the report should be publicly disclosed, the Commission will need to:

- confer with PWC to determine whether PWC claims that certain information included in the report is confidential information; and
- identify which information in the report the Commission considers is confidential information in accordance with section 26(1) of the Act.

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<sup>1</sup> Section 6(2) of the *Utilities Commission Act*.

## **Background**

1. The Commission is an independent statutory body with defined roles and functions for economic regulation in the electricity, water and sewerage industries in the Territory. The Commission was established on 21 March 2000 by the Act.
2. On 14 March 2014, the Commission received a request from the Treasurer (Regulatory Minister), in accordance with section 6(1)(g) of the Act, to undertake an independent investigation into the System Black incident that occurred on 12 March 2014 in the Darwin-Katherine power system. One of the functions of the Commission is to advise the Regulatory Minister on any matter referred by the Regulatory Minister to the Commission.
3. The request from the Minister included Terms of Reference for the investigation. A copy of the Terms of Reference is provided at Attachment A.
4. The Commission was due to provide its report to the Minister on 27 March 2014. The Commission sought an extension to this due date to allow further consideration of specific technical aspects of the System Black incident. The Minister approved an extension to 2 April 2014.
5. To assist with the investigation, the Commission engaged Evans & Peck, an international engineering consulting firm with detailed knowledge of the Territory's power system. The Commission also engaged CQ Partners, who have particular expertise in relation to power system operations.
6. The Commission also received advice during the conduct of this review from the Australian Energy Market Operator (AEMO), the operator of the energy markets and systems for the National Electricity Market (NEM).
7. This summary report provides the Commission's key findings and recommended actions arising from the investigation of the System Black incident which occurred on 12 March 2014. It also comments on the regulatory framework applying to the Territory electricity industry, including issues of reliability and security of electricity supply. The Evans & Peck report, which is included at Attachment B of this report, provides a more detailed assessment of the incident and constitutes part of the Commission's overall response to the Terms of Reference. Both the Commission's summary report and the Evans & Peck report combine to address the matters raised in the Terms of Reference.
8. To undertake the review, the Commission sought information and responses from PWC. A copy of the information notice issued to PWC in accordance with section 25 of the Act is provided at Attachment C. The Commission also reviewed the results of investigations undertaken by PWC, including an initial report provided to the Minister on 13 March 2014 and a more detailed interim investigation report provided to the Minister on 26 March 2014.
9. The Commission acknowledges that the data required to prepare this report, and much of the initial investigation, was necessarily supplied by PWC. This report could not have been prepared without the cooperation and assistance of PWC staff.

## **Description of the System Black Incident**

10. The following is a brief summary of the events that led to the System Black incident of 12 March 2014. Section 3 of the Evans & Peck report provides a detailed description of the sequence of events.

11. In the early hours of 12 March 2014, PWC was preparing to undertake planned maintenance work on one of the three 132/66kV (high voltage) transformers at the Hudson Creek Terminal Station. Prior to undertaking the work, it was necessary to isolate the transformer from the electricity supply network through a switching sequence.
12. Switching is the process of operating equipment (such as a circuit breaker) either to allow or prevent the transfer of electricity across parts of the electricity network. In this case, it was to prevent the transfer of electricity to the 132/66kV transformer so that maintenance work on this high voltage equipment could be carried out.
13. PWC had undertaken a risk assessment and prepared switching instructions for the work. Although the risk assessment sheet associated with the isolation switching was comprehensive and procedurally correct, the plan for the switching was not signed off, which indicates that the final check process did not occur.
14. The switching plan also included a very obvious error that was not picked up at any point prior to implementation of the switching plan. This error led to the unnecessary attempt to open a 132kV circuit breaker (CB 602) that failed to operate correctly. In fact, CB 602 was scheduled for operation on the following night in a separate piece of maintenance work.
15. Once the switching sequence commenced, that circuit breaker (CB 602) malfunctioned at 00.40.<sup>2</sup> A halt was called to the planned maintenance work and it was decided to carry out repairs on this circuit breaker. This required a new switching sequence so that the malfunctioning circuit breaker could be isolated. Although the circuit breaker had malfunctioned, the power system remained in a stable state (although at high risk from any further single contingency equipment failure) with electricity from Channel Island Power Station (CIPS) flowing through other circuit breakers.<sup>3</sup> Immediate work on the malfunctioning circuit breaker was not essential, although it would have been necessary to have scheduled such work in the near term.
16. A plan was developed to undertake a new switching sequence to isolate the malfunctioning circuit breaker. This plan was not prepared in accordance with standard work instructions, was not signed off by anyone (including the preparer)<sup>4</sup> and no risk assessment was documented.
17. At 01:21, PWC opened another circuit breaker (CB 302) to begin the process of isolating the malfunctioning circuit breaker. This created a partial disruption of power flow from CIPS that was seen as a fault by automatic protection systems, which then opened four circuit breakers that disconnected CIPS from the network and tripped Weddell generating unit 1 and Pine Creek generation sets.
18. Over the next eight minutes a chain of events unfolded, including the operation of automatic protection systems and manually operated commands that resulted in a System Black (loss of all electricity supply) in the Darwin-Katherine system at about 01.30.

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<sup>2</sup> Evans & Report, System Black Darwin-Katherine 12 March 2014 Investigation, 2 April 2014 page 5.

<sup>3</sup> *ibid*, page 5.

<sup>4</sup> *ibid*, page 12.

## Key Findings

19. The following section outlines the Commission's key findings from its investigation into the 12 March 2014 System Black incident. These have been identified from the Commission's consideration of the information and evidence provided to it as part of the investigation process. As noted earlier, the Evans & Peck report at Attachment B constitutes part of the Commission's overall response to the Terms of Reference. The Evans & Peck report contains an additional set of findings in relation to the incident and these are endorsed by the Commission.

### ***Root Cause of the Incident***

20. The root cause of the incident was the action taken by PWC in response to the malfunctioning of the first circuit breaker (CB 602). The failure of the circuit breaker on its own did not lead directly to the System Black incident. Following the malfunction of the first circuit breaker, the power system continued to operate normally for another 40 minutes and this may have continued for some considerable time if left 'as is'. It was the switching procedure developed by PWC to isolate the malfunctioning circuit breaker to carry out its repairs that caused the protection to trip the Channel Island to Hudson Creek transmission lines and subsequently disconnected generating units at CIPS, WPS, Pine Creek Power Station and Katherine.<sup>5</sup> Generation-related issues at CIPS and WPS Power Station further prolonged the period of the System Black.
21. Just over one minute after the first circuit breaker (CB 602) failed to open correctly, an attempt was made to reclose it. Luckily, the protection systems prevented this. It would not be considered good practice to operate a circuit breaker that has just failed to operate correctly. This command should not have been issued.<sup>6</sup> The time delay between the open and close operations suggests that there was little thought given to the impact of a reclose operation.
22. Given that the system continued to be in a stable state, albeit with the risk of a failure of another critical circuit breaker, there was opportunity for PWC to evaluate the status of the power system, consider what action should be taken to alleviate the situation, undertake an appropriate risk assessment, test its course of action and obtain appropriate authorisation of any switching plan.<sup>7</sup> These actions are particularly important given the critical nature of the high voltage equipment and risk to the community of loss of supply. Since the Darwin-Katherine system has less redundancy than most other Australian systems, including the NEM, it is much more critical for operational staff to respond correctly to incidents.
23. In fact, as noted previously, a plan of action to deal with the malfunctioning circuit breaker (CB 602) was hastily devised with no apparent risk assessment or checking. This would not be acceptable in the NEM and is not in accordance with PWC's standard work instructions.<sup>8</sup> The switching plan was fundamentally flawed in that circuit

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<sup>5</sup> *ibid*, page 12.

<sup>6</sup> *ibid*, page 5.

<sup>7</sup> *ibid*, page 18.

<sup>8</sup> *ibid*, page 18.

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breaker CB 302 should not have been opened as the initial action. Inevitably, this led to the partial disruption of power flow from CIPS.

24. Within 30 seconds of the tripping of the two CIPS circuits, the previously opened circuit breaker (CB 302) was reclosed. This appears to have been a hasty reaction to the trips which were caused by the opening of CB302. However, the reversal of the latest switching operation will rarely return the power system to its previous state and will often create more problems than it solves. This operation was not a considered response to the power system configuration.
25. Within minutes after the two CIPS circuits tripped, all four of their circuit breakers were reclosed and supply was restored to the Darwin 66kV network. By this time, under frequency load shedding had correctly shed stages 1 – 4, leaving some 20MW of load on the Darwin system. However, this sudden change led to instability in the CIPS generating units. The 66kV circuit breakers at Hudson Creek Terminal Station were manually opened in an attempt to reduce the Darwin load, but there was no reduction of load until the last of the circuit breakers was opened. This removed stabilising load from the remaining Channel Island generating units, which then also tripped, and all supply was lost to Darwin and Katherine.
26. In isolation, the inaccurate switching plans followed by hasty switching operations could be attributed to simple human error, but, when combined (and further exacerbated by the failure of both CIPS and WPS black-start generators), they give the Commission concern that there may be a lack of adequate procedures, training and understanding of the potential impacts on power system security.
27. The Commission's focus here is not with the operators on-shift at the time of the System Black incident or those who developed and reviewed the switching plans. Rather, the Commission's concern is to question whether the appropriate systems and procedures are in place, operators are appropriately trained and experienced, and off-line operating staff or resources are available for advice or authorisation to ensure that the most appropriate decisions are made in the interest of power system security.
28. In the NEM, AEMO manages security across the network but it does not own or operate any high voltage equipment. Any physical incidents, similar to the 12 March 2014 incident, would be the responsibility of the Transmission Network Service Provider (TNSP) to manage. AEMO's function would be to approve any switching and ensure that, where necessary, constraints were applied to the NEM market systems so that system security was maintained. In relation to planned switching, the TNSP would be responsible for preparing a switching program which would be approved by AEMO (several weeks in advance) and carried out under AEMO's oversight. Isolating, earthing, issuing permits and the actual work would be carried out by the TNSP and all steps would be checked and countersigned by a second person to minimise any risks associated with the work. Separation of roles and responsibilities does not exist within PWC but similar processes for accountability and focus on power system security are at least as important.

### ***Condition of the 132kV Circuit Breaker CB 602***

29. The original switching at the start of the maintenance work attempted to open a three pole circuit breaker (that is, a circuit breaker with three switches that operate in

parallel), but this was unsuccessful as one of the three poles failed to open. There are limited maintenance records prior to 2010, but it is understood that the circuit breaker was in need of routine maintenance (programmed for June 2014) and that the risks associated with the circuit breaker were well known to PWC.<sup>9</sup>

30. This circuit breaker is critical to the operation of the power system and there is a high risk to power system security when it is taken out of service, since a further single contingency failure could result in the loss of supply from CIPS. This reduces the opportunity to remove it from service for maintenance apart from a window between 00:00 and 04:00 hours. However, it is unrealistic to expect high reliability from equipment which has limited access for maintenance.
31. It is understood that PWC has had concern with the condition of the 132kV circuit breakers at Hudson Creek Terminal Station since at least August 2011 and that plans had been put in place to undertake intrusive maintenance. It is understood concerns with taking a circuit breaker out of service for a prolonged period of time meant that, around July 2013, plans were put in place to purchase a new circuit breaker and swap out existing circuit breakers for maintenance in the dry season of 2014.<sup>10</sup>
32. CB 602 also malfunctioned in April 2012 and a similar circuit breaker malfunctioned in April 2012 and September 2013. A full condition assessment of the 132kV circuit breakers should be undertaken as a priority, including a risk assessment of the possibility of future failures on power system security. Depending on the outcome, an acceleration of critical maintenance and/or replacement may be required.

#### ***Configuration of the Hudson Creek 132kV Switchyard***

33. The design of the Hudson Creek 132kV switchyard adds an extra element of risk when undertaking routine maintenance work. If the circuit breaker that malfunctioned (CB 602) is out of service, the opening of any other 132kV circuit breaker at Hudson Creek will reduce the power that can flow through to the 66kV system. Section 11 of the Evans & Peck report contains a list of consequences if a further 132kV circuit breaker at Hudson Creek opens while circuit breaker CB 602 is out of service.
34. The issues with the configuration of the switchyard should be incorporated into any plan to undertake maintenance work in order to mitigate this risk as much as possible. Deviating from the original maintenance plan (which contained an error) to a new plan so quickly could not have appropriately factored in this extra risk.

#### ***Lack of Islanding Scheme***

35. The tripping of circuit breakers at Channel Island disconnected CIPS from the Hudson Creek Terminal Station at around 01.21. It also created two separate power islands, with Darwin supplied by WPS and Katherine, Pine Creek and Batchelor supplied by CIPS and Pine Creek Power Station. However, both of these power islands were unstable and quickly collapsed.

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<sup>9</sup> *ibid*, page 13.

<sup>10</sup> *ibid*, page 23.



36. A power island is an arrangement in which a generator and some local load have been disconnected from the remainder of the electricity network, but where the generator continues to supply power to itself and that local load. Islanding schemes placed at strategic locations have the potential to separate the power system into naturally resilient power islands that can support the re-energisation of the wider network. Recovery from a completely de-energised state is significantly more difficult than from an already energised power island. Creation of power islands, as an alternative to complete shutdown, dramatically shortens system recovery time.
37. Currently, there are no under-frequency/under-voltage islanding schemes implemented within the Territory's regulated power systems. This was previously identified during the investigation of the 30 January 2010 System Black incident,<sup>11</sup> which resulted in a shorter duration but similarly wide spread power system outage. Following this incident, the System Controller at the time recommended that an islanding scheme be developed. This recommendation has not been progressed to date.

### ***Failure of Black-Start Generators***

38. During the System Black incident of 12 March 2014, attempts to restore CIPS and WPS were made by PWC using the black-start generators at both sites. Attempts to black-start both power stations were unsuccessful for different reasons.
39. CIPS has two black-start generators, the original Kongsberg machine (900kW) and a new Cummins machine (1 500kW). The Cummins machine did not start due to control arrangements that prevented sufficient voltage to be generated to start the motors needed to start the main unit. It is understood that this is a temporary problem and was fixed later in the morning to allow this generator to start the CIPS units. This black-start generator is in a temporary location and not yet fully integrated into the power station.
40. The Kongsberg machine was tried, but it failed shortly after coming on line. This unit had been regularly tested on a monthly basis, but the February test was not conducted as the Cummins unit was tested instead. The reason it failed to operate when required needs to be identified and regular testing maintained to confirm that the issues identified have been rectified and the unit is reliable.
41. The black-start generator at WPS was left in the 'OFF' position, meaning WPS could not be started. This also resulted in the uninterruptible power supply (UPS) batteries not being charged. As a result, power was not supplied to critical systems once the batteries discharged. It is unclear how long the black-start generator had been turned off.
42. In isolation, an issue with the black-start generators at either WPS or CIPS may not have been insurmountable, but having issues simultaneously at WPS and CIPS contributed to the length of the restoration process.

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<sup>11</sup> Power and Water Corporation, Darwin Katherine Power System, Investigation Report arising from the System Black of 30 January 2010 v.2.0.

### **Outdated System Black Procedures**

43. Clause 5.7.3 of the System Control Technical Code (SCTC) requires the System Controller to develop a Black System Restart Procedure for each of the regulated power systems and requires these procedures to be reviewed annually by 31 October. Further details on the responsibilities and obligations on the System Controller are provided on pages 9-10 of this report.
44. The Black System Restart Procedure for the Darwin-Katherine power system has not been reviewed since May 2010, shortly after the last System Black event that occurred in January 2010. This may be a breach of the SCTC and also of a condition of PWC's system control licence. PWC's Interim Investigation Report also identifies that the Black System Restart Procedure for the Darwin-Katherine power system needs to be updated.<sup>12</sup>
45. There have been significant changes to the power system since the 2010 System Black incident, including the decommissioning of the Berrimah Power Station, the commissioning of CIPS generating units 8 and 9, commissioning of WPS generating unit 3 and the conversion of more CIPS generating units to run only on gas fuel. Updating these procedures to account for developments to the system and to incorporate findings from this investigation process needs to be addressed as a priority.
46. The SCTC also requires generators to develop Black System Procedures<sup>13</sup> for each of its power stations and that these are to be incorporated into the System Controller's Black System Restart Procedure<sup>14</sup>.
47. The SCTC requires these procedures to detail the step-by-step functions to be carried out by the generator as well as the corresponding instructions from System Control in the event of a black system.
48. Clause 5.7.2(c) of the SCTC requires Generators' black-start procedures to be submitted to System Control and approved by System Control. In discussion with System Control, it was identified that black-start procedures had been received for Katherine Power Station and the Alice Springs power system. However, no black-start procedures had been received for CIPS and WPS. This may also be a breach of the SCTC and of a condition of PWC's generation licence.
49. PWC's Interim Investigation Report also identifies that black-start procedures and work instructions need to be updated for CIPS.<sup>15</sup>
50. Procedures for black-start generators need to be reviewed as a matter of priority. The haphazard approach to the black-starting of CIPS and WPS could have been improved if there were appropriate guidelines to be followed after the System Black occurred.

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<sup>12</sup> Power and Water Corporation, Interim Investigation Report v1.0, page 13.

<sup>13</sup> Clause 5.7.2, System Control Technical Code v4.0, June 2012.

<sup>14</sup> Clause 5.7.3(b), System Control Technical Code v4.0, June 2012.

<sup>15</sup> Power and Water Corporation, Interim Investigation Report v1.0, page 11.

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**Possible Breaches of the System Control Technical Code and System Control Licence Conditions**

51. As discussed above, the Commission's preliminary view is that failure to review the Black System Restart Procedure for the Darwin-Katherine power system and failure to submit and approve black-start procedures for CIPS and WPS may be a breach of the SCTC. The Commission will liaise directly with PWC to ensure that any breaches are remedied.
52. In addition, clause 2.2 of PWC's system control licence states that the licensee (PWC) has the function of monitoring and controlling the operation of the power system with a view to ensuring that the power system operates reliably, safely, securely and efficiently in accordance with the SCTC.
53. The Commission is concerned that the issues relating to errors in switching plans, and lack of appropriate authorisation for switching plans, may represent a breach of PWC's obligation to operate the power system in a reliable, safe, secure and efficient manner.
54. The Commission's expectation is that PWC would take appropriate action as a matter of priority to remedy any material breaches of its licence conditions and the SCTC. However, the Commission may consider the application of other enforcement measures following further review.
55. In accordance with its authority under clause 11.4 and 10.4 of PWC's system control and generation licences respectively, the Commission will require PWC to appoint an independent auditor to undertake an audit of PWC's compliance with its obligations under the licences. The selection of the independent auditor and scope of the audit will be determined by the Commission and include a rigorous examination of PWC's compliance with its obligations under the SCTC and review of switching procedures and practices in comparison to good electricity industry practice. PWC will be responsible to pay the costs of undertaking the audit in accordance with its licence conditions.

**Crisis Management and Recovery response**

56. While it appears that the Crisis Management and Recovery process adopted for the 12 March 2014 System Black incident operated in accordance with PWC's Corporate Crisis and Recovery Manual, PWC needs to consider the appropriateness of its management and recovery response and how this interrelates with the Black System Restart Procedure. There needs to be a clear distinction between the role of the System Controller and the Crisis Management and Recovery Team during the event and the recovery phase.
57. A review of these procedures is particularly important given that the electricity market has changed with the licensing of two new retailers since 2011, and that there will potentially be structural separation of PWC.
58. It is noted that there was representation by PWC Retail in the Crisis Management and Recovery Team that included advising of priority customers during the event. Information was communicated to PWC Retail during the recovery phase, presumably to advise its customers. No details are included in the event log of information disseminated to other retailers, who also may have had priority customers. PWC's Interim Investigation Report also notes that "what appeared to be a delay in notifying Retail (PWC Retail) of the System Black incident, Retail responded quickly and

effectively to get call centre operations up and running”.<sup>16</sup> No reference is made to notifying other retailers.

### **Possible GSL Payments**

59. From the Commission's investigation, it appears that the interruption to the supply of electricity caused by the System Black incident on 12 March 2014 most likely constitutes a failure to meet one or more of the guaranteed service levels for PWC Networks (the networks business unit of PWC) set out in clause 2.1.4 of the Guaranteed Service Level (GSL) Code. Under the GSL Code, PWC Networks is required to make GSL payments to small customers where PWC Networks does not meet the required guaranteed service levels and the reason for that failure is not excluded under the terms of the GSL Code. The System Black incident could give rise to GSL payments to eligible customers for whom power supply was interrupted for more than 12 hours.
60. The GSL Code places the onus on PWC Networks to establish whether or not the cause of these interruptions falls within an exclusion category, and to make payments to affected customers as appropriate. The Commission will monitor compliance by PWC Networks with its obligations under the GSL Code.

### **The Regulatory Framework**

61. The Commission has issued separate electricity licences to PWC for generation, network services, system control and retail services.<sup>17</sup>
62. In accordance with Part 3 of the *Electricity Reform Act*, the Commission granted a licence to PWC<sup>18</sup> to exercise control over the power systems of Darwin-Katherine, Alice Springs and Tennant Creek. In accordance with its licence, PWC has the function of monitoring and controlling the operation of the power system with a view to ensuring that the power system operates reliably, safely, securely and efficiently in accordance with the SCTC.
63. The System Controller also has statutory responsibilities under section 38 of the *Electricity Reform Act* for monitoring and controlling the operation of the power systems to ensure the power systems and electricity networks operate reliably, safely and securely in accordance with a technical code prepared by the System Controller and approved by the Commission.
64. The System Controller is responsible for oversight of compliance by system participants with the SCTC. The Commission has a general responsibility for oversight of compliance by licence holders with the regulatory framework, including compliance by the System Controller and market participants.
65. In addition to its statutory roles, System Control also performs network operation functions for PWC Networks and operates the after-hours call centre for all of PWC.

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<sup>16</sup> Power and Water Corporation, Interim Investigation Report v1.0, page 35.

<sup>17</sup> PWC also has separate licences for the provision of water supply and sewerage services.

<sup>18</sup> System Control Licence issued to Power and Water Corporation 1 July 2008 (and varied 28 February 2011).

These additional roles may distract System Control from its core function of monitoring and controlling the operation of the power systems.

66. In June 2012, following repeated requests from the Commission, amendments were made to the SCTC to include power system incident reporting arrangements more consistent with good electricity industry practice. The incident reporting arrangements detail the process for investigation and reporting of incidents and the threshold for reportable incidents.
67. Outside this System Black investigation process and PWC's preliminary and interim reports to the Treasurer on the incident, System Control is required to provide the Commission with an initial report within 14 days of the incident, containing key details of the event and incident, and the scope of the investigation, with a final report as soon as is practical after the event. From inception of the incident reporting arrangements, it is understood System Control has had difficulty complying with the requirements primarily due to resourcing constraints.
68. The Commission's authority to enforce compliance with the incident reporting arrangements is limited to its ability to seek a civil penalty in the Supreme Court of the Northern Territory for a contravention of a condition of PWC's System Control licence.
69. A key component of the incident reporting arrangements is that the report should reflect good electricity industry practice. In this regard, the Commission has encouraged PWC to focus on implementation of recommendations from previous System Black and other incident reports, with possible public reporting of such progress in implementation. The Commission has no authority to enforce implementation of such recommendations.
70. The Commission has previously highlighted that it considers the Territory's regulatory and institutional arrangements for System Control are not consistent with the arrangements designed to promote good governance, in that:
  - there are potential conflicts of interest between the performance of supervisory functions and for-profit electricity supply activities;
  - performance of system operation functions may be perceived as not being conducted independently of the interests of the PWC Generation or Networks business units;
  - there are difficulties in holding generators and PWC Networks accountable for the performance of functions and outcomes against stated requirements, because the operating requirements are not clearly stated and data availability is poor; and
  - the regulatory arrangements do not clearly define the tasks required of businesses at each part of the electricity supply chain.<sup>19</sup>
71. In February 2014, the Commission provided a report to the Minister recommending proposed changes to the wholesale electricity market, including, amongst other things, establishment of clear and distinct roles within PWC System Control in relation to system planning and system and market operations.<sup>20</sup>

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<sup>19</sup> Utilities Commission, Review of Electricity System Planning and Market Operation Roles and Structures – Final Report January 2012.

<sup>20</sup> Utilities Commission, Review of Wholesale Electricity Generation Market – Final Report February 2014.

## **Commission's Recommendations**

72. In this section, the Commission makes various recommendations concerning action in response to its key findings as detailed in the previous section. As noted previously, the Evans & Peck report at Attachment B constitutes part of the Commission's overall response to the Terms of Reference. The Evans & Peck report also makes recommendations in relation to the System Black incident of 12 March 2014, and these are endorsed by the Commission.
73. The Commission also endorses the detailed recommendations made in the PWC Interim Investigation Report provided to the Minister on 26 March 2014 but notes that it will be essential to prioritise the implementation of these recommendations to ensure that implementation can be managed appropriately within a reasonable timeframe.

### ***Review of Switching Process and Procedures***

74. The Commission recommends a detailed review of PWC's switching processes and procedures including the development, implementation and authorisation of switching procedures. The Commission considers this a high priority.
75. The review should also consider the staffing, training, experience and management structures of System Control in comparison with good electricity industry practice
76. There should be training of all relevant personnel to confirm that the switching sheet preparation procedures must be followed to the letter and that all checking must be performed in detail.
77. Forms should be made available to the PWC Control Room so that switching operations are formally logged with times and signatures included.

### ***Review of 132kV Circuit Breaker Condition***

78. Given the age and apparent poor condition but critical importance of the 132kV circuit breakers at Hudson Creek Terminal Station, a full assessment should be undertaken on the condition of these breakers and the risks of future failures on power system security. Any other circuit breakers posing similar risks to the security of the system should also be considered for replacement.
79. A full condition assessment of the 132kV circuit breakers needs to be undertaken as a priority, including a risk assessment of the possibility of future failures of power system security. Depending on the outcome, an acceleration of critical maintenance may be required.

### ***Implementation of an 'Islanding' Scheme***

80. The Commission recommends that an islanding scheme be developed as a matter of priority. The investigation into the System Black event of 30 January 2010 recommended that system islanding schemes be implemented at strategic locations in the system. This is to enable restoration of the power system from a functional power island significantly reducing recovery time.
81. To date, there have been no under-frequency/under-voltage islanding schemes developed or implemented within the Territory regulated power systems. A proposed schedule for location of power island separation points for the Darwin-Katherine power

system should be developed. The Commission understands that a schedule was previously supplied to PWC Networks after the 2010 System Black incident with associated recommendations for implementation. This schedule should be re-examined and, if unavailable or considered unsuitable (for example, because of system changes since 2010), a new schedule should be developed and implemented.

### ***Review System Black Procedures and Black-Start Procedures***

82. The Commission recommends a review of PWC's Black System Restart Procedure and incorporation of black-start procedures for CIPS and WPS to ensure compliance with the SCTC and good electricity industry practice.

### ***Implementation of Report recommendations***

83. The Commission recommends development of a documented and authoritative process for the reporting and implementation of recommendations from power system reports. The lack of progress in implementing an islanding scheme after the 2010 System Black incident confirms that a structured follow-up mechanism for monitoring actions against recommendations is warranted.
84. This should include monitoring of implementation of recommendations arising from the 12 March 2014 System Black investigation and other power system reports with appropriate reporting and accountability to the PWC Board.
85. The reporting mechanism should also require the PWC Board to report to the Shareholding Minister. Potentially, there could be a role for the Commission or another independent body to review progress or the failure to prioritise appropriately.
86. There are 55 recommendations from PWC's internal investigation into the System Black incident. More analysis is required and prioritisation should be undertaken to ensure that implementation of the key recommendations is achievable within a reasonable timeframe.
87. Government should also consider issuing a direction to PWC (through the Treasurer) to report back to Government, by a specific date, on PWC's plan to implement the recommendations from its own investigation reports and the Commission's investigation. PWC should be required to detail what actions it proposes to take in relation to each recommendation and within what timeframe.

### ***Changes to the Regulatory Framework***

88. As discussed above, the actions that the Commission can take to ensure that the implementation by PWC of recommendations made in this System Black investigation and previous incident reports are limited by the current regulatory framework.
89. Disciplinary action by the Commission in relation to potential breaches by PWC of the SCTC and its generation and system control licences is also limited by the current regulatory framework.
90. It is recommended that Government consider whether amendments should be made to the current regulatory framework to ensure the transparency and accountability of PWC in operating a reliable, safe, secure and efficient power system.

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**ATTACHMENT A – Terms of Reference from the Regulatory Minister****INDEPENDENT INVESTIGATION INTO THE 12 MARCH 2014  
DARWIN-KATHERINE SYSTEM BLACK  
Terms of Reference****Background**

On Wednesday 12 March 2014, at approximately 1.19am, a fault occurred which resulted in an extended System Black power outage from Darwin to Katherine.

Power and Water Corporation's (PWC) preliminary assessment of the situation is that a fault with a circuit breaker at Hudson Creek substation in Darwin was activated shutting down transmission from Channel Island Power Station resulting in a widespread power outage extending from Darwin to Katherine affecting some 65,000 customers.

PWC are undertaking a full investigation into the course of the incident.

**Referral**

Pursuant to section 6(1)(g) of the *Utilities Commission Act*, the Commission is to conduct an independent investigation into the system black incident that occurred on 12 March 2014.

**Scope of Investigation**

The independent investigation is to address the following matters:

1. description of the power system situation that existed prior to the system black incident, the sequence of events leading to the incident and the state of the power system after the incident, plus any related subsequent incidents;
2. identifying root causes of the incident from a technical standpoint including any operational and maintenance activities;
3. history of the performance of Hudson Creek substation and any other transmission and distribution infrastructure involved in the incident;
4. the response of generators to the disturbance and their protection systems;
5. standards and procedures followed by System Control to mitigate the risk of system insecurity and their performance against these standards during this event;
6. assessment of any other the causal factors and factors contributing to both the occurrence and severity of the incident;
7. assessment of the adequacy and speed of the response to the incident, including external communication;
8. assessment of the time taken to restore the system and power system restoration activities including prioritisation and assessment of restoration needs;
9. recommendations for actions that may be required to prevent a recurrence of such an incident including the design of the power system and related power system operation and maintenance practices;
10. what impacts, if any, did gas supply have on the incident; and



11. if the above matters are unable to be addressed within the specified timeframe, recommendations for subsequent investigations and appropriate timing.

All results from PWC's internal investigation will be made available to the Commission.

The Commission is to draw on external technical resources as it considers appropriate, including consultation with the Australian Energy Market Operator.

### **Timing**

The Commission is to provide a report to the Minister by 27 March 2014.\*

[\*The Minister approved an extension to 2 April 2014 on 27 March 2014]

## **ATTACHMENT B – Evans & Peck 12 March 2014 Darwin-Katherine System Black event**

The report from Evans & Peck includes the following components:

- executive summary;
- introduction;
- state of the system;
- root cause analysis;
- performance history of relevant network assets;
- generator response;
- risk mitigation procedures followed by System Control;
- causal factors;
- speed of response;
- power system restoration;
- recommendations to avoid a recurrence;
- impact of gas supply on restoration duration;
- subsequent investigations; and
- overall conclusions.

## ATTACHMENT C – Information Request to Power and Water Corporation

### INFORMATION REQUEST

The Commission has received notice from the Treasurer, pursuant to section 6(1)(g) of the *Utilities Commission Act*, to undertake an independent investigation into the System Black event that occurred in Darwin-Katherine on 12 March 2014.

In accordance with section 25 of the *Utilities Commission Act*, the Commission requires Power and Water Corporation to provide the following information by **4.00pm Thursday 20 March 2014**.

#### Part A - Documents and Policies

- 1) Provide asset management and maintenance plans for the 132kV circuit breakers at Hudson Creek.
- 2) Provide the maintenance and testing records for these circuit breakers for the last three years.
- 3) Provide the approved switching plan used for the isolation of the 132/66kV transformer, the approval process and the signed off switching plan as implemented.
- 4) Provide the contingency plans developed to manage identified contingencies associated with this work.
- 5) Provide constraints that were applied to network and generation assets to manage identified contingencies.
- 6) Provide the power system configuration immediately prior to the incident.
- 7) Provide the history of the performance of Hudson Creek Substation and any other network assets involved in the incident.
- 8) Provide data detailing the response of the generating units to the incident and the operation of their protection systems.
- 9) Have the units at Weddell and Channel Island (especially 8 & 9) undergone full load rejection tests to house load as part of their acceptance tests, and if not why not? Is this part of a regular testing regime on these units?
- 10) Provide asset management and maintenance plans for the Black Start Generators at Channel Island.
- 11) Provide the maintenance and testing records for the Black Start Generators at Channel Island for the last three years.
- 12) Provide asset management and maintenance plans for the Black Start Generators at Weddell.
- 13) Provide the maintenance and testing records for the Black Start Generators at Weddell for the last three years.
- 14) Provide asset management and maintenance plans for the Black Start Generators at Hudson Creek.
- 15) Provide the maintenance and testing records for the Black Start Generators at Hudson Creek for the last three years.
- 16) Provide all operator logs, event recorder outputs and other recordings and data from System Control, Networks and the power stations relevant to the incident.
- 17) Provide a copy of the Crisis Management and Recovery Manual.

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- 18) Provide the membership of the Crisis Management and Recovery Team, their responsibilities and tasks, the decisions made by the team and the timing of these decisions.

#### Part B - Analysis and Assessment

- 1) What caused the breaker to fail? Have similar failures on these breakers occurred in the past? Is there information from similar failures on this type of breaker at other utilities? What steps are being taken to prevent a similar occurrence on other similar circuit breakers?
- 2) Provide details of the protection systems on the Channel Island to Hudson Creek 132kV circuits and the 132/66kV transformers at Hudson Creek. Provide details of the relay operation on this equipment, and confirm whether or not the relay operation was correct for the type of fault encountered. Provide details on the operation of any other network protection systems.
- 3) What is the series of events that caused the second Channel Island to Hudson Creek 132kV line to trip?
- 4) How was the implementation of the switching plan being supervised?
- 5) What contingencies had been identified prior to the work being undertaken?
- 6) What were the standards and procedures followed by System Control and Networks to mitigate the risks of identified contingencies? Were these standards met?
- 7) Provide the details of the restoration process, including details of delays in restoration, how was the order in which loads were restored prioritised, and the timeline for restoration of all customers.
- 8) Provide the sequence of events leading to the incident and follow on incidents such as the tripping of Channel Island units on return to service.
- 9) Provide the rationale for having only one unit at Weddell on line given the risk of losing Channel Island generation.
- 10) Why wasn't Weddell able to "island" itself, generating at house load or with an islanded load suitable to its capacity. Provide the operating procedure for this operating state or if not available when is it intended to develop such a procedure?
- 11) Why weren't the units at Channel Island able to "island" themselves, generating at house load? Provide the operating procedure for this operating state or if not available when is it intended to develop such a procedure?
- 12) What was the cause of the failure of gas supply to Channel Island, and how was it rectified? How will a reoccurrence of this be prevented?
- 13) What was the equipment failure at Weddell that prevented the return to service of the Weddell units? Did this affect all three units? How will a reoccurrence of this be prevented?
- 14) What caused the units at Channel Island to have the house load provided by the Black Start Generators for an extended period of time, such that the reconnection of customers was delayed?
- 15) What damage was caused to units 4, 5 and 6 at Channel Island and why? How will a reoccurrence of this be prevented?
- 16) What were the ICT problems experienced at Hudson Creek and how can they be avoided in the future?
- 17) Provide details of the process and timeframes for providing responses to external parties, and an assessment of performance against accepted procedures and standards.